

SCIENCE

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BUTTER AND OLEOMARGARINE.

THE form and character of the fats employed as articles of food vary from the raw and solid fats of the whale and seal, eaten by the inhabitants of exceedingly cold climates, to the raw and liquid fats, mostly of vegetable origin, consumed in tropical climates. In temperate climates the form, whether solid or liquid, of animal or vegetable origin, is a matter of education.

The fats present to the animal economy one of the most important functions of food, that of supplying heat and energy. "Ten grains of butter, when burnt in the body, produce heat sufficient to raise 18.68 pounds of water 1° F., which is equal to raising 14,421 pounds 1 foot high."¹

The potential energy of fats is greater than that of nearly all other articles of food. According to Dr. Rubner, as quoted by Professor Atwater,² one gram of fat yields 9.3 calories, or 14.2 foot-tons; that is to say, "when a gram (one-twenty-eighth of an ounce) of fat, be it the fat of the food or body-fat, is consumed in the body, it will, if its potential energy be all transformed into heat, yield enough to warm a kilogram of water 9.3° of the Centigrade thermometer, or, if it be transformed into mechanical energy such as the steam-engine or the muscles use to do their work, it will furnish as much as would raise 1 ton 14.2 feet, or 14.2 tons 1 foot."

A gram of proteine, myosin (lean) of meat, white of egg, caseine (curd) of milk, gluten of wheat, etc., or of carbohydrates, starch and sugar, yields 4.1 calories, or 6.3 foot-tons,—less than half as much energy as an equal quantity of fat. Of course, only a small portion of the whole energy is made available for external muscular work: the rest is transformed into heat. Professor von Gohren,³ as the result of elaborate computation, reckons that a horse may transform 32 per cent, an ox may transform 43 per cent, a man may transform 53 per cent, of the whole potential energy of his food into energy for mechanical work.

In regard to the relative digestibility of butter and oleomargarine, see the article on "Foods and Food Adulterants," in *Science* of April 11, 1890, p. 229.

Butter was unknown to the ancient Greeks,—at least, no reference is made to it by Homer or Aristotle,—and even to this day is a great rarity in Mexico and South America and in certain portions of China. Herodotus and Hippocrates described, in the fifth century B. C., the butter which the Scythians obtained from mare's milk by violent agitation,

and Dioscorides states that the best butter is made from sheep's and goat's milk. It was not in common use in England until after the fourteenth century. It is less frequently eaten by barbarous than by civilized nations. It is made from milk, chiefly from that of the cow. That from the bison is employed in Egypt and India, and that from the goat in other countries.

Milk is a natural emulsion, in which the globules of fat exist in a very minute state of division. Their usual size is $\frac{1}{5000}$ of an inch, but varies with the nature of the food used; and they are scattered through the whole substance as long as the fluid is in motion, but, when it is allowed to rest, these globules coalesce, and form cream.

The flavor of the butter differs according to the animal from which the milk is derived, and varies with the nature of the food, turnips and leeks imparting a peculiar strong taste. The color varies likewise with the animal and its food, from nearly white to very yellow. To give butter a uniform tint, the addition of annatto or other coloring-matter is very often resorted to.

The adulteration of butter with "additional coloring-matter" is legalized by the Oleomargarine Law,—although such addition be "intended fraudulently to conceal its inferior quality," to use the language of the British Sale of Food and Drugs Act, 1875,—and is a practice which should be more honored in the breach than in the observance than it usually is. While the coloring-matters used are harmless for the most part, their use tends to deceive the purchaser into supposing that a white, winter, is a yellow, spring, or Jersey butter.

The manufacture of butter has for its object the further coalescing of the fat-globules contained in the milk, and depends on mechanical means for its accomplishment. Butter made from whole milk, or scalded cream, contains more caseine (curd) than if made from cream in the ordinary way. This is important as not only affecting its taste, but also its keeping properties; for caseine, being a nitrogenous body, is liable to undergo fermentation, in which case the butter becomes decayed or rancid. When special pains are taken to "work the butter" thoroughly, thus more effectually getting rid of the water and buttermilk, it keeps for a much longer period in a "sweet" condition. The use of from 1 to 10 per cent of salt, and also saltpetre, as a preservative is quite common.

Ghee, which is so extensively used by the natives of India, is prepared from bison's milk. The milk is boiled, cooled, a little sour milk added, churned, hot water added, and in about an hour butter is produced. The butter is allowed to

¹ Foods, E. Smith (New York, 1874), p. 136.

² Century, vol. xxxiv., p. 401.

³ Naturgesetze der Fütterung, 1872, pp. 372-378.

become rancid, when it is clarified by being boiled with dhye, or sour milk, and salt or betel-leaf, and is then kept in closed pots for use. It has a peculiar flavor, which is distasteful to Europeans.

In some parts of Europe the butter is boiled at a gentle heat for a couple of hours, with constant stirring, allowed to cool and settle, and the melted mass is decanted while still liquid into crocks, care being taken not to allow the caseine, or cheesy mass, to intermix. The butter so prepared will keep for a long time without becoming rancid.

Butter is the best-known of all non-nitrogenous animal foods (fats), but is consumed in very different quantities, varying from the large cupful, as drank before breakfast by the Bedouins near the Red Sea and Persian Gulf, to the thin layer, as eaten at most meals on the slice of bread by the inhabitants of this country.

Butter is defined by the Oleomargarine Law as the food-product "which is made exclusively from milk or cream, or both, with or without common salt, and with or without additional coloring-matter."

Butter is composed principally of butter-fat, with a small and variable quantity of water, caseine or curd, and some salt, which has been added to preserve it and bring out its flavor.

The following table shows the extremes in composition of numerous samples of butter, as found by various analysts, in regard to their proximate analyses:—

Table I. — *Extremes in Composition of Numerous Samples of Butters.*

ANALYSTS.	NUMBER OF ANALYSES.	WATER.			FAT.			CURD.			SALTS.		
		Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.
König ¹	123	35.12	5.50	14.49	85.25	76.37	83.27	4.77	0.25	1.29	5.65	0.08	0.95
Bell ²	117	30.75	4.15	14.20	93.12	72.93		5.32	0.11	1.20	15.08	0.50	
U. S. Department Agriculture ³	52	17.44	4.44	10.49				1.23	0.26	0.60	7.10	1.08	3.27
Hassal ²	48	28.60	4.18		96.93	67.72					8.24	0.30	
Hehner and An- gell ²	30	16.00	6.40	10.57	90.20	76.40	85.15	5.10	1.10	2.18	8.50	0.40	2.09
Ellis ⁴	12	10.50	4.90		89.70	80.80		4.90	1.10		6.20	0.10	
Larue ⁴	12	16.50	8.00		86.90	79.14		5.50	1.50		3.60	0.40	
Schacht.....	8	9.00	1.25		98.00	87.00		0.50			6.00	0.57	

¹ European markets.

² Great Britain.

³ American.

⁴ Toronto.

What is commonly or commercially known as a simple fat is chemically almost invariably a mixture of several different fats, called glycerides; and the name by which they are designated terminates in "ine," e.g., butyrine, stearine, etc. These glycerides are the normal propenyl ethers of the fatty acids, or, in other words, compounds of the triad alcohol, glycerine, with the fatty acids.

Glycerine has the property of uniting with one, two, or three molecules of fatty acid, affording mono-, di-, or tri-glycerides, designated according to the acid. In almost all the natural fats these glycerides occur as trivalent; and in speaking of them the prefix "tri" is generally omitted, being understood. The most commonly occurring glycerides are,—

Tri-stearine, $C_3H_5 (C_{18}H_{35}O_2)_3$, which occurs in almost every animal and vegetable fat. It may be obtained in a considerable degree of purity in plates of a pearly lustre by repeated crystallizations from ether. It is inodorous, tasteless, neutral, and volatilizing without decomposition under reduced pressure. It is solid at all ordinary temperatures. Its melting-point is from 52° to 69.7° C. (125.6° to 157.4° F.).

Tri-palmitine, $C_3H_5 (C_{16}H_{31}O_2)_3$, which occurs in animal and vegetable fats, and especially in palm-oil, whence its name, and may be obtained by repeated crystallizations from hot ether, in white pearly laminae. The crystals melt at from 46° to 62° C. (114.8° to 143.6° F.).

Tri-butyryne, $C_3H_5 (C_4H_7O_2)_3$, which is found chiefly in butter. At ordinary temperature it is liquid, and has a distinct and peculiar taste and smell.

Tri-oleine, $C_3H_5 (C_{18}H_{33}O_2)_3$, which occurs in almost every animal and vegetable fat. It is liquid at all ordinary temperatures, neutral, odorless, and tasteless.

Wein¹ found in butter-fat more or less of the glycerides of palmitic, oleic, stearic, myristic, arachidic, normal caprylic, capric, normal caproic, and butyric acids. Glycerides of acetic and formic acids were also found, but not those of propionic, valeric, oenanthylic, or pelargonic acids. The greater part consists of the glycerides of oleic and palmitic acids, that of stearic acid being usually present in smaller quantity. The characteristic constituent of butter-fat is butyrine, which ranges from 5 to 8 per cent.

Olive and cottonseed oils are composed chiefly of tri-oleine and tri-palmitine.

Mutton suet consists chiefly of tri-stearine, with small quantities of tri-oleine and tri-palmitine.

Human fat contains tri-palmitine with some tri-oleine and tri-stearine.

Beef suet contains the same glycerides and the same quantity of tri-oleine as mutton suet, but the percentage of tri-palmitine and tri-stearine is about a mean between the latter fat and human fat (Heintz).

Lard has more tri-oleine than either beef or mutton suet, and less of the other two glycerides, tri-palmitine and tri-stearine.

¹ Sitzungsber. d. Phys. Med. Soc. Erlangen xl., p. 1664.

The differences in these natural fats are due to the different proportion in which these glycerides are mixed, and to such other physical differences as the various sources of the substance under examination would produce. When subjected to chemical and physical examination, a discrimination can be made between fats and oils of different origins.

According to Blyth,¹ the general composition of butter fat and butterine (oleomargarine) fat appears to be as follows:—

	Butter-Fat.	Butterine-Fat.
Palmitine	{ 50.00	{ 22.3
Stearine		{ 46.9
Oleine	42.21	30.4
Butyrine	7.69	{ .4
Caproine and capryline	.10	
	100.00	100.0

The following analyses, made by Drs. Brown and Mott, show the characteristic difference in the composition of genuine butter and oleomargarine to consist in the greater proportion of soluble fats contained in the former:—

	Genuine Butter.	Oleomargarine.
Water	11.968	11.203
Butter solids	88.032	88.797
	100.000	100.000
Insoluble fats:		
Oleine, palmitine	23.824	24.893
Stearine, arachine, myristine	51.422	56.298
Soluble fats:		
Butyrine, caprine, caproine, capryline	7.432	1.833
Caseine	.192	.621
Salt	5.162	5.162
	88.032	88.797

The discovery of Mège Mouries, in 1867, of a process for the manufacture on a large and cheap scale, from hitherto waste products of the large slaughter-houses, of an artificial butter, is one of the most important advances in industrial chemistry of this century. His object was to obtain a fat "which melted at almost the exact temperature of butter, possessed a sweet and agreeable taste, and which, for most purposes, could replace ordinary butter; not, of course, the finest kind, but which was superior to it in possessing the advantageous peculiarity of keeping for a long time without becoming rancid." He was employed on the Imperial Farm at Vincennes, and his experiments were undertaken at the instance of the French Government.

In 1870 a factory for the manufacture of this new butter substitute was in operation near Paris, at Poissy, and the product was called "margarine." The war then intervened, and suspended the operations of this factory; but at the cessation of hostilities they were resumed. In April, 1872, the Council of Health of the Department of the Seine, on

the favorable report of M. Felix Boudet, admitted the new product to the trade under the proviso that it was not to be sold as butter. The process was patented in England in 1869, and in this country in 1873, and was described in many of the trade and scientific journals of that time.

The process of Mège may be briefly described as follows: The fat from the loins and kidneys of freshly slaughtered beeves is thoroughly washed in cold water, 16° to 18° C. (61° to 65° F.), for two or three hours, then hashed fine and melted in steam-jacketed vats, in which the temperature is carefully regulated, with the addition of a little pepsin or a portion of the finely divided stomachs of calves or pigs, together with a little caustic alkali or alkaline carbonate, at a temperature of about 45° C. (113° F.). The charge usually is, hashed raw fat, 1,000 parts; water, 300 parts; sodium, or potassium carbonate, 1 part; and stomachs, 2 parts. The mass is stirred and kept at a temperature of 45° C. for two to three hours, and allowed to settle. The melted fat is drawn off through hair sieves from the top, and run into the settling-tanks. In these tanks the fat is kept melted at 45° C. until it becomes clear; the addition of salt, about 2 per cent, hastening the operation. The mass is then cooled at a temperature of 23° to 25° C. (73° to 77° F.), whereby a large proportion of the stearine and palmitine separates in the solid state, leaving the oleine, much of the palmitine, and some stearine in a pasty state. The mass is placed in bags and subjected to hydraulic pressure. The temperature of the pressing-room is maintained at 25° C. The oily product expressed constitutes the "oleo oil," or "oleo," which is the principal ingredient of oleomargarine. The hard fat remaining in the press is turned over to the candle and soap makers. The average yield is stated to be, hard fat, stearine, palmitine, 40 to 50 per cent; oleo oil, 50 to 60 per cent. This oleo oil is nearly colorless, tasteless, and at ordinary temperature is a soft, granular fat, rather than an oil.

To make it into the artificial butter, it is necessary to impart to it the color and aroma it still lacks. For the former, annatto or turmeric is used; and for the latter, fresh milk, cream, or genuine butter. To effect an intimate mixture of the flavoring and coloring matter with the oleo, it is necessary to emulsify the fat. Mège discovered that the udder of a cow contains a substance, extractable by water, which will emulsify the fat. The operation is carried on in churns. The usual charge is, liquid oleo, 200 pounds; fresh milk, 40 to 50 pounds; aqueous extract of the udder, 40 to 50 pounds; and coloring-matter in suitable quantity. The churning is kept up for two hours at as nearly 17° C. (63° F.) as possible. The product is treated essentially in the same way as ordinary butter,—washed, drained, salted, and packed.

The yield is stated to be as follows: one ox affords 166 pounds of crude fat; 56 pounds caul fat, giving 36 pounds of artificial butter, besides 6 pounds of scrap.

Mège's original process has been modified from time to time. The use of pepsin or of calves' or pigs' stomachs has gradually been abandoned.

Though numerous patents have been taken out in this country for the manufacture of artificial butter, and materials unknown to science specified as ingredients to be used, the process employed is comparatively simple, and not patented.

The process used in this country consists in preparing from

¹ Foods, pp. 285, 287.

the suet and other fats of the beef and hog a fat deprived of the larger part of its more solid constituents, viz., stearine and palmitine, whereby a product is obtained that resembles butter-fat in certain properties.

The aim of the manufacturer is to so combine the oleo oil, neutral lard, and cottonseed oil with a certain small portion of creamery butter or cream as to produce an artificial butter having the appearance and taste of the natural product as closely as possible. There are several grades manufactured, containing a greater or lesser amount of genuine butter, which determines the price.

Sir F. A. Abel, C.B., F.R.S., in his testimony before the English Committee, stated that the process employed in one of the most extensive works in Holland was briefly as follows:—

“A quantity of milk is churned for a short time, together with a sweet oil, such as that known as ground-nut oil or sesame oil; a quantity of oleomargarine equal to about half the weight of the other ingredients is then added to this churned mixture; and the churning is then continued, at about 80° or 90° F., for about a quarter of an hour. In most cases, in order to give the true butter flavor to the butterine to a greater extent than can be obtained by the use of the milk alone, a proportion of a very strong-flavored butter, either Danish or Dutch, is added toward the close of the churning. When the mixture has been sufficiently churned, it is allowed to flow out of the churn in a stream, which meets a stream of ice-cold water. The sudden refrigeration of the mixture which I have described has the effect of preventing any crystalline formation, or the formation of crystalline particles, and produces a granular structure quite similar to the structure of ordinary butter. I should state that a small quantity of what is known as butter-coloring matter, or annatto (which is the coloring-matter used generally in the coloring of genuine butter of different descriptions), is added before the churning is completed. The butter-like substance which is obtained by the refrigerating action to which I have alluded, is passed between rolls, with the addition of a sufficient quantity of salt to render it thoroughly palatable and to preserve it; and the butterine is submitted to the usual finishing operation for sale in the market.

“Oleomargarine is the product of a treatment of what is commonly called sweet beef fat; that is to say, the fat from beef is carefully looked over in order to see that no tainted portions remain. It is then submitted to a crushing process in order that the membrane may afterwards more readily separate from the fat. It is submitted to melting, and allowed to subside for some time, so as to separate the pure fat from the membrane. The pure fat is then drawn off, and, when perfectly clear, is allowed to cool, until the mixture is rather more than semi-solid; and in that condition it is placed between cloths in a condition somewhat similar to marrow, and submitted to very powerful pressure. The hard portion of the fat remains behind as stearine, and the portion that is liquid at that temperature passes away, together with a small proportion of the harder constituents of the fat; and that constitutes the oleomargarine. In butterine there is no fat introduced except in the form of oleomargarine.”

American Methods of Manufacturing Oleomargarine.

The following ingredients enter into the manufacture of oleomargarine as pursued in this country: oleo oil, neutral

lard, some liquid vegetable oil (as cottonseed, sesame, or peanut); butter in the higher grades, cream, and milk, together with salt, and annatto or other coloring-matter. A brief statement of the general system pursued in the preparation of the ingredients, and of the finished products, may not be uninteresting. Very few of the oleomargarine manufacturers make their own oleo oil or neutral lard, and none of them refine or crush the vegetable oils used in the lower grades of oleomargarine, but buy them in the open market, these materials being now well-established commercial products.

The manufacture of oleo oil is generally carried on in connection with the large slaughter and packing houses situated in or near the principal cities, where every effort is made to utilize all portions of the cattle slaughtered. The caul and suet fats are removed from the freshly slaughtered beeves, and placed in tanks filled with water at 75° to 85° F., where they remain from two to three hours before being transferred to other tanks containing ice-water. By this procedure the fats are gradually deprived of their animal heat, and the danger of their becoming sour is avoided, as would happen if the mass of fat was suddenly chilled by being placed directly in ice-water. The caul, long, or slaughter fat is kept separate from the suet fat, which yields an inferior grade of oil.

A Texan steer will yield, on an average, 65 pounds of caul and suet fats, from which are obtained 28 pounds (43 per cent) oleo oil, 21 pounds (32 per cent) oleo stearine, and 12 pounds (20 per cent) high-grade tallow. The chilled fats, having been thoroughly washed to remove any blood that may be present, are then sent to the rendering tanks. These are generally in a separate building from the slaughterhouse. Fat from cattle slaughtered late in the afternoon is generally kept in the ice-water tanks over night before being rendered; thus no fat is more than twelve or fourteen hours on hand, and the great majority less than four hours, before it is rendered. The fat is fed into choppers or hashers, revolving at a high rate of speed, from which it issues through fine sieves directly into the rendering-tank. This is a large steam-jacketed upright kettle of 2,000 to 5,000 pounds capacity, provided with revolving blades driven by suitable machinery. Steam being turned on in the jacket, the hashed fat is fed continuously into the tank, and kept in motion by the stirrer. When the tank is full and the contents thoroughly melted, the temperature being 120° to 155° F., the stirrer is removed, and the water and scrap allowed to settle. The clear fat is drawn off from the top, and run into the graining or seeding cars of 400 to 600 pounds capacity, where it is allowed to chill. The temperature of the room in which these cars are stored is maintained at 85° to 95° F. The fat, in chilling, naturally solidifies gradually; the hardest variety, the stearine, being the first to form a thin crust on top and sides. In from one to three days the whole contents of the car will be in a semi-solid condition. This fat is free from all “greasy” taste. The car containing the semi-solid fat is taken to the press-room, which is maintained at a temperature somewhat below that of the seeding-room, viz., 70° to 80° F., where it is dipped out by ladle and poured on a stout linen cloth, placed in a suitable depression on a wooden revolving table, and, after the cloth is properly folded so as to make a rough bag, it is transferred to the

metal plate of a screw-press. A dozen of these cloth bags cover the surface of a plate. When one plate is covered, another one is let down and filled.

When the press is filled, pressure is gradually applied by means of an endless chain revolving a screw. The expressed oil constitutes the oleo oil. This liquid fat is conducted, still hot, from the press into barrels or cars, where it is allowed to cool. The finished product is nearly colorless, tasteless, and at ordinary temperatures is a soft, granular fat, rather than an oil. The hard fat remaining in the filter-bags is removed from the press, and forms the beef or oleo stearine, which is used either for making refined or compound lard by the addition of cottonseed oil, or sold to the soap and candle makers.

The manufacture of neutral lard is conducted by essentially the same machinery and at about the same temperature employed in the manufacture of oleo oil. Only the leaf-fat of freshly slaughtered hogs is used. A hog yields from 5 to 15 pounds of leaf-lard, averaging 9 pounds, 100 pounds of which yield 90 pounds neutral. The neutral, however, is not pressed to extract the stearine, but is run directly from the rendering-tank into a very strong iced brine, where it remains for about twenty-four hours, when it is removed, and placed on shelves to drain. The neutral is a white, slightly granular, tasteless, solid fat. The skimmings and scrap from the lard-rendering kettles are strained, and the fat (about 2 per cent of the original charge) obtained from them added to the steam-rendered product. Several factories, however, use the ordinary steam and kettle-rendered lards, and not neutral. Great cleanliness is observed throughout both processes, and there is very little manual handling; machinery being used as much as possible, and the fat carefully guarded from any source of contamination.

The by-products of oleo oil and neutral — viz., stearine, tallow, and lard — are standard merchantable articles. Only fresh and sweet fats are used; and tanks, etc., are thoroughly cleaned before use, as a small amount of fat, if allowed to adhere to the apparatus, is liable to decompose in such a way as to spoil the succeeding batch of materials worked up.

Though there may be slight differences in the details, the range of temperature, size of tanks, etc., pursued by the different manufacturers, the general procedure is as above described, the object being to obtain a neutral fat, melting at butter temperatures.

The vegetable oils are prepared by crushing the seeds, etc., and subjecting the crushed mass to hydraulic pressure, or by extracting the oil by carbon bisulphide or other solvent. The crude oil thus obtained is refined to remove the coloring-matter by treatment with mineral acids, and subsequent neutralization by alkalies, and chilling and pressing, whereby a product is obtained of a light straw-color and bland taste.

The butter used is always selected for its high flavor and taste, and is generally obtained direct from the creamery. Owing to the granular character of oleo oil it becomes necessary to add some softer and smoother fat; and neutral lard and cotton-seed, or other similar vegetable oil, are added for the purpose of making the mixture more closely approach the consistency of butter. The proportions in which these ingredients are used vary with the seasons of the year, the grade desired, and the formulas of the manufacturers. The charge of milk or cream, however, is the same for all grades

manufactured by any particular factory, and varies from 10 to 20 per cent. The milk or cream is allowed to become slightly sour.

The churn used is steam-jacketed, of 1,200 to 2,500 pounds capacity; and the whole operation of churning is conducted at a temperature of 85° to 105° F., insuring the melting and thorough mixture of the solid fats used, thus differing from ordinary creamery practice. The oleo oil and neutral lard are melted in separate kettles at a temperature of about 90° F. The charge of milk or cream is first run in, and the paddles kept in motion until the butter begins to form. Then the charge of melted oleo oil is added and stirred. When this is well incorporated, the neutral lard is run in, and finally the annatto, to give the desired butter-color. The butter is added either directly into the churn, being first melted, or it is worked into the oleomargarine after it is taken from the churn. The temperature is carefully regulated, being about 85° F. at the beginning, and gradually increasing to 105° F. at the end, when the whole charge has the appearance of a yellowish, creamy fluid. From twenty to ninety minutes are occupied in the churning. The whole melted charge, after it has been sufficiently churned to thoroughly incorporate all the ingredients, is run either directly into tanks containing chopped ice and constantly stirred, or is met by a stream of ice-water as it issues from the churn. The object is to give the melted mass a fine grain by this sudden cooling. The chilled mass is removed from the tanks, and placed on wooden trays to drain. Here the salt is added and allowed to work itself in, which generally takes from twelve to twenty-four hours. The salted mass is then thoroughly worked by mechanical rollers, to remove the buttermilk and water, following the general practice of creameries in this and subsequent operations of packing, etc.

Oleomargarine is placed on the market either "solid packed" or in prints or rolls. Four grades are generally made, known as "dairy" and "extra dairy oleomargarine," creamery," and "extra creamery butterine," the last two containing from 10 to 25 per cent of the best creamery butter. In the lower grades, from 25 to 60 per cent of neutral lard, from 20 to 50 per cent of oleo oil, from 5 to 25 per cent of vegetable oils, and in some cases from 2 to 10 per cent of butter, with 10 to 20 per cent of milk or cream, are the proportions used. Some factories employ no vegetable oils in their oleomargarine, preferring to use a larger proportion of neutral lard with a small amount of butter to obtain the desired butter consistency. In the higher grades the proportions of oleo oil are reduced, the vegetable oils are discarded, and creamery butter is used to make up the charge.

[To be continued.] EDGAR RICHARDS.

NOTES AND NEWS.

It is reported that a deposit of coal of good quality has recently been discovered in West Australia.

— The enormous increase in the frozen meat export trade from New Zealand during the past few years must be exceeding gratifying to all persons interested in the colony. The value of the exports to Great Britain in 1882 amounted to only about nine two thousand dollars, while in 1887 it had risen to upwards of two million dollars. Over a million carcasses of mutton are now sent annually to England, and there seems to be every prospect that the trade will go on increasing at a similarly rapid rate.

—A very odd result of rivalry between two tiger-snakes is recorded by Mr. D. Le Souef, Assistant Director of the Melbourne Zoölogical Gardens, in a recent number of the *Victorian Naturalist*. One of the snakes was large, the other being small. Not long ago both happened to fasten on the same mouse, one at each end. Neither would give way, and the larger snake not only swallowed the mouse, but also the smaller snake. In about ten minutes nothing was seen of the smaller snake but about two inches of its tail, and that disappeared next day.

—In an experiment made by the North Carolina experiment station, a series of plots was laid out in such manner that one end of each plot should be on land on which cow peas had been previously plowed under, and the other end on land without peas. The whole was sown to wheat, and kainite, acid phosphate, and cotton seed meal were applied to the several plots, singly and in combination, two plots being left without any fertilizer. The result was that on the land which had had no cow peas the highest increase of any of the fertilized over the unfertilized plots was four bushels per acre (for 300 pounds of cotton seed meal), while on the green manured land the increase from the pea vines was from six bushels at the least to fifteen bushels per acre, averaging ten bushels.

—With all their learning and teaching power, the German universities retain some rather unlovely traditions, of which duelling is perhaps the most redolent of barbarism. True, the vast majority of "hostile meetings" between undergraduates seldom result in more than facial disfigurement; but sometimes, when firearms are the weapons chosen instead of swords, danger is inevitable, and even death may occur. A melancholy illustration of this has lately been witnessed at Wurzburg, where, as narrated by the *Lancet*, a highly promising and amiable "candidatus medicus" lost his life. Paul Fleurer, the unfortunate youth in question, seems to have played a truly chivalrous part in the encounter; for after a first, and then a second, interchange of shots, he held out his hand twice in token of reconciliation with his antagonist, but in vain. A third interchange was insisted on, and poor Fleurer fell mortally wounded, and died in a few minutes. At his funeral, which was attended by the students in large numbers, and with all the insignia of mourning, *oraisons funèbres* were delivered, the principal of which referred to the deceased as the victim of an "unfortunately still prevailing prejudice"—surely an inadequate condemnation of a practice which finds no favor in the better-mannered academic life of Great Britain and America.

—A bulletin of the Ohio Agricultural Experiment Station, now in press, gives the results of an experiment in feeding sugar beets to milch cows, made during the past winter, together with a summary of two similar experiments, one made by the station in 1889 and one by the farm department of the Ohio State University in 1879. In the last named experiment eight cows were kept under test for eleven weeks; in 1889, twelve cows for eight weeks; and in 1890, twelve cows for nine weeks, the cows in each case being weighed daily, as well as their feed and milk. In each of the three experiments the cows ate more hay and more total dry matter when feeding on beets than on other foods (hay, meal, and bran in 1879, corn silage in 1889 and 1890), and in each case more milk was given from the beets than from the other foods, but it is not yet demonstrated that the increase of milk was produced economically. For twelve years records have been kept on the farm now occupied by the station, which shows that the average yield of beets over this period has been nearly sixteen tons per acre, against an annual yield of about fifty-five bushels of shelled corn per acre. But a crop of fifty-five bushels of shelled corn, with its fodder, will contain nearly twice as much dry matter as sixteen tons of beets, and these experiments indicate that, whether fed dry, as corn meal and dry fodder, or as corn ensilage, the dry matter of the corn crop will be found about as effective, pound for pound, as the dry matter of the beet crop. It is possible to raise much more than sixteen tons of beets to the acre. One crop of two acres is reported at thirty-seven and one-half tons per acre, and smaller areas have given still larger yields, but such crops require very rich land and thorough culture. Whether it is possi-

ble to produce a pound of dry matter in beets as economically as it can be done in corn is not yet definitely settled, but the probabilities are against it.

—A Royal Commission has been appointed in England to inquire and report "what is the effect, if any, of food derived from tuberculous animals on human health, and, if prejudicial, what are the circumstances and conditions with regard to the tuberculosis in the animal which produce that effect upon man." Lord Basing is chairman. The other Commissioners are Professor G. T. Brown, Dr. George Buchanan, Mr. Frank Payne, and Professor Burdon Sanderson.

—The following method for preserving ice in a pitcher will not come amiss to those who need it for use all night or in the sick room. Fill the pitcher with ice and water, and set it on the centre of a piece of paper; then gather the paper up together at the top and bring the ends tightly together, placing a strong rubber band around them to hold it close, so as to exclude the air. *The Medical and Surgical Reporter* says that a pitcher of ice-water treated in this manner has been known to stand over night with scarcely a perceptible melting of the ice.

—The corrosion of steel by salt water is said to be much greater than that of iron. Mr. David Phillips stated in a recent address before the British Institute of Marine Engineers, says *Engineering News*, that he had experimented from 1881 to 1888 with two plates of Bessemer boiler steel, two of Yorkshire and two of B. B. Staffordshire boiler iron. The plates were, as nearly as possible, 6 by 6 by $\frac{3}{8}$ inches, and were kept immersed in salt water. The results show a great difference between the behavior of steel and iron. The steels lost 120 per cent more than the irons the first three years, when the plates were in contact; 124 per cent more the second three years, when they were insulated; and 126 per cent more for the whole period of seven years.

—The number of vessels passing through the Suez Canal at night by means of electric light is increasing with extraordinary rapidity. The regulations for the use of the electric light went into operation in March, 1887, and during the remainder of that year (according to statistics given in *Engineering*) the number using it was 394. In 1888 the number rose to 1,611, and in 1889 it reached 2,445. Prior to March, 1887, the privilege of travelling by night with electric light had been restricted to vessels carrying the mails. Since then all ships which conform to the regulations are allowed to proceed by night. The average time of transit has also been considerably shortened. In 1886 it was 36 hours; in 1887, 33 hours 58 minutes; in 1888, 31 hours 15 minutes; and in 1889 it had been reduced to 25 hours 50 minutes. The average time for vessels using the electric light in 1889 was 22 $\frac{1}{4}$ hours. The shortest time taken by a steamer in the transit of the canal in 1889 was 14 $\frac{1}{2}$ hours, which is ten minutes less than the fastest passage on record previously.

—Artificial musk is a recent chemical achievement. A process for its production has been patented in Germany, the inventor being Herr A. Bauer, of Gisparsleben, in the Erfurt district. It is a familiar experience in organic chemistry, that on introduction of nitro groups (NO_2) into organic bodies, by action of nitric acid, a smell like that of musk is often noticed. In the present process, as described by *Nature*, pure butyl-toluol is treated with a mixture of sulphuric and nitric acid, and the nitro-compound is purified by crystallization from alcohol, the yellowish white crystals smelling strongly like musk. According to Dr. Paul (*Humboldt*), the smell is not perfectly pure, and it can be distinguished from that of musk by the perfumer, but not by the general public. Curiously, a one per cent alcoholic solution has not the smell of musk. Only after dilution with water does this come out, and the dilution may be carried far before the smell is lost. With 1 in 5,000 it is still quite distinct. Certain properties of the new product seem to render it very useful in the perfuming of soap.

—In the new quarterly statement of the Palestine Exploration Fund, Mr. Flinders Petrie gives a short report of his recent excavations at Tell Hesay, in Palestine, which, *Nature* says, prove to be remarkably interesting. The remains of Tell Hesay consist of a mound which is formed of successive towns, one on the ruins of

another, and an enclosure taking in an area to the south and west of it. The lowest wall of all—28 feet 8 inches thick, and formed of clay bricks, unburnt—is believed to be that of Lachish, the ancient Amorite city, erected probably 1500 years B.C. Phœnician pottery of about 1100 B.C. is found above its level. Later constructions are the supposed wall of Rehoboam, and remains of the fortifications made in the reigns of Asa, Jehoshaphat, Uzziah, Jotham, and Manasseh. The pottery discovered on the spot is very valuable. "We now know for certain," says Mr. Petrie, "the characteristics of Amorite pottery, of earlier Jewish, and of later Jewish influenced by Greek trade, and we can trace the importation and the influence of Phœnician pottery. In future all the tells and ruins of the country will at once reveal their age by the potsherds which cover them."

—The Brooklyn *Medical Journal* quotes from a German authority the following review of the physiological effects of saccharin, the new sweetening agent. According to the investigations of Plugge, a .03 per cent solution of saccharin entirely destroys the action of ptyalin, and hinders the action of pepsine and pancreatine. On this account it is injurious to diabetics, to whom a good digestion is very important. On the other hand, E. Gans, Stevenson, and Wooldrige express the opinion, based upon their experiments, that saccharin is not injurious to the digestive processes, but it hinders the secondary decompositions of the contents of the intestinal canal. The Royal Academy of Medicine at Madrid has given the opinion that the addition of saccharin to foods and drinks should be regarded as an adulteration, and that articles of food, or drink, so treated should be refused entrance into Spain. A similar judgment has been given by the Academy of Medicine at Rio de Janeiro. France has adopted laws forbidding its use in foods.

—The British Vice-Consul at Los Angeles, California, in a late report, has some observations on the vine and orange pests in that region. As summarized in *Nature*, the report states that the vine disease now seriously menaces the existence of the viticultural industry in the vicinity of Los Angeles. At first it attacked chiefly the "mission" vines; now, other varieties of red vines are dying, and the white varieties are also suffering. The disease first appeared in its present dangerous form in the southern part of California, and destroyed many vineyards. Professor Dowlen, an expert employed by the Viticultural Commission to ascertain its cause, and, if possible, discover a remedy, inclines to the opinion that it is due to a fungus. On the other hand, Mr. Wheeler, Chief Executive officer of the Viticultural Commission, reports that he is fully convinced that the fungus found on the dead vines is not the prime cause of their decadence, and that it attacks them only when they have been weakened by other causes. As to the *Icerya*, or "white scale," which has ravaged the orange-groves, the Vice-Consul says that a year ago many of the principal orange-growers in the vicinity of Los Angeles had abandoned their efforts to exterminate this pest, concluding that their trees must die. Fortunately, it was learned that an Australian parasite, the *Vedolia cardinalis*, had exterminated the white scale in Australia. A colony of the bugs was imported, and placed on the trees in an orchard in Los Angeles. They multiplied so rapidly that in a few months the scale was entirely exterminated in the district, and many trees which a year ago were nearly dead, have revived and borne half a crop this season.

—In a recent article on slag cements, a French authority, as quoted in a recent issue of *Engineering*, states that these cements are made by finely grinding blast-furnace slag, and mixing it with a suitable proportion of fat lime. The grinding has to be very fine, because as the cement is made by a simple mixture it is necessary that the surface on which the two constituents, the lime and the slag, react on each other should be as large as possible, if proper chemical combination is to ensue. As manufactured in France, the cement leaves only 20 per cent on a sieve containing upwards of 25,000 meshes per square inch, and only 8 to 10 per cent on a sieve with 4,500 meshes per square inch. The density of slag cements is much less than that of Portland, weighing bulk for bulk, but from .8 to .88 times as much. In general, this cement also sets somewhat more slowly than Portland, but when hardened, has, in many cases, a greater strength, particularly at

early dates after setting. In some experiments still unfinished, the following results were attained with a slag cement from the Department of Isère:

Age.....	1 week,	1 month,	3 months.
Breaking load, pounds per square inch.....	473.5	568.8	678.3

These figures are higher than any attained in the tests made on Portland cements for the new Croton aqueduct. Experiments were also made with slag-cement mortar mixed with and allowed to harden in sea-water, and gave the following results; the mortar consisted of six parts by weight of cement to ten of sand.

Age.	Breaking	Weight,	Pounds per Square Inch.
8 days.....	252.0	319.9	275.1 273.0 285.8
28 ".....	375.4	327.0	327.0 248.4 341.2

The main objection to slag cement seems to be that if it is allowed to harden in dry air its strength is very materially reduced, and it is then liable to crack. In the town of Villefranche-sur-Saone it has been largely used for paving foot-paths.

—The dangerous overcrowding of the London cemeteries has been often commented on by the medical press of that city, says the *Medical Press*, but the evil remains almost wholly unabated. The Sanitary Committee of the London County Council has reported that no time should be lost in closing burial grounds such as the Brompton, which contains 155,000 bodies, and the Tower Hamlets Cemetery, with its 247,000 bodies crowded into only seventeen acres. The average grave is seven by three feet, and contains eight adults and fourteen children, the covering of earth being about one foot. In one instance, a committee of inquiry regarding this cemetery found eighty infants in a grave or trench of less dimensions than that of the average grave. There are twenty-one burial places, with a total extent of less than three hundred acres, holding a million and a quarter of bodies. The soil in most of these places is clay, and the process of decomposition goes on so slowly that bodies buried for a dozen years remain remarkably well preserved.

—The use of preservatives for articles intended for food and drink is an important one, both for the manufacturer and consumer, says the Brooklyn *Medical Journal*. From a sanitary point of view, it is doubtful whether any of the preservatives ordinarily added to articles intended for human consumption ought to be encouraged. Laws exist in Continental European countries prohibiting the use of certain of these preservative agents. Salicylic acid is prohibited by most of them, and the manufacturers are there beginning the use of benzoic acid, which is preservative in small amount and is not easy to detect. After a discussion at a convention of chemists at Speyer, Bavaria, on the 10th of September, 1888, the conclusion was reached that boric acid, as a preservative for foods, is to be regarded with caution. Sanitary authorities have generally spoken in stronger terms of the use of boric acid, and yet it enters into the composition of a large number of the preservatives in the market. Hirschsohn gives a description of several different boro-glycerides which he recommends for preserving foods. Boro-glycerine is prepared by heating glycerine with boric acid, in the proportion of 124 of the former to 190 of the latter. He also recommends sodium, calcium, and magnesium glyceroborates. These compounds are mostly tasteless, and quite soluble in water and alcohol. Magnesium borate is recommended as a remedy in throat affections. A. R. Rosen recommends the following method for preserving meats: Boric acid or its salts are dissolved in water and the solution is then frozen. The article to be preserved is then covered with this ice, with the result that the meats are preserved after the ice melts. Dr. E. Polenske has made an examination of ten commercial preservatives intended for meats. Three of the ten contained sulphurous acid or sulphites; two contained borax, and five boric acid; one each contained alum, arsenious oxide, salicylic acid, and free phosphoric acid; two contained glycerine, and two boroglycerine; three contained nitre, and six common salt. The one containing arsenious oxide was the only one actively poisonous, but several of the others was decidedly objectionable. Indeed, we should object to the addition of anything to our meats which is not a natural ingredient of food or cannot be converted into a compound natural to the human body.

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FOREST CULTURE IN HANOVER.

IN various parts of the United States the question has been raised, by what measures the preservation of forests and the plantation and culture of trees might be most effectually promoted in parts void of timber. In connection with this it might be desirable to learn something about the state of forest management in the province of Hanover. This province, the former Kingdom of Hanover, according to a report by Consular Agent Simon to the State Department, had rich tracts of forests in former centuries, which, in consequence of civil and other wars at various times, were reduced to desolate wastes and remained so until the first decades of the present century, particularly those extents between Hamburg and Hanover, which are known by the name of Luneburger Haide (Lunenburger Heath).

Besides those wars, another reason for such devastation is to be attributed to uncongenial management, such as division of common forests, by which they were dispersed and fell into the hands of people with small means, and thus were doomed to neglect and destruction. Those singly situated wooded tracts, for want of screenings, have greatly suffered by the detrimental, inclement winds, which is easily understood, since large forests will defy the violence of storms better than small woods.

Great credit for having made up for past neglect and faults is due to the celebrated Burkhardt, who, being a great authority in this matter, was appointed Director of the forest department in 1850. Part of the Luneburger Haide, as well as other tracts growing more and more desert by the encroachments of sand, have

been wooded with great pains and trouble at his instigation. To prevent the increase of sandy deserts those tracts were at first planted with fir-trees. These could, in some parts, after a number of years, be cleared and substituted by beach and other trees. How much the forests have been enlarged in this manner will appear by the following statement: The wooded surface amounted in the year 1850 to 1,217,625 acres; 1885, 1,551,900 acres. By such plantation of trees river-bank and sea shore tracts have been solidified. In order to promote the establishment of forests in every respect, the Government has granted large sums for the purchase of landed property unfit for cultivation to be turned into forest tracts. The Government is now keenly intent to unite again those formerly scattered wooded parts into one single tract. In the same way the Provincial Government and Klosterkammer (Administration of cloister funds) proceed by purchasing extensive stretches of soil. The Klosterkammer administers the large funds of the secularized cloisters of the former Kingdom of Hanover, now used for the support of universities, schools, and churches in this province.

Municipalities, communities, and even private individuals who are inclined to establish forest grounds and manage them rationally will receive loans at 2 per cent and even cheaper from the Provincial Government, to be reimbursed yearly by small instalments. Also, single subsidies are granted for once for the turning of large wastes into forest grounds. For the latter purpose the provincial government resorted to a new and original method, by using vagabonds, tramps, and prisoners not of a dangerous character for forest culture, and, indeed, according to experience, with great advantage both with regard to the workers and forest culture. In this manner about 9,000 acres were planted with trees by those troublesome classes within the years 1876 to 1888. Moreover, communities as well as private individuals have turned about 14,000 acres into forest grounds within the same period by means of subsidies afforded by the Provincial Government. Besides, the matter of forest culture is encouraged and promoted on the part of the Government, as well as the provincial authorities, by the establishment of nurseries, where plants and young trees are to be had at very moderate prices.

By a legal preservation of forests in the vicinities of towns pleasant walks are created for the pleasure and health of the inhabitants, without regard to the material profit of those places. At a short distance from the old city of Hanover, for instance, was the so-called Eilenreide, a forest of about 1,500 acres, which the city now partly encircles. This forest has essentially contributed to the reputation of Hanover, with regard to sanitary condition, to the extent of its being now, according to statistics, one of the healthiest cities in Germany. Several smaller towns which own extensive forest grounds and manage them in a rational way, clear by the net yielding of those woods the whole of their municipal expenses; as, for instance, the town of Munder, situated at the foot of the Deister Mountains. The town of Goslar derives an income of \$25,000 to \$30,000 from an extent of 7,500 acres of forest grounds. Every traveller on an excursion to Goslar and other parts of the Hartz Mountains will have admired the fine, practical forest roads which facilitate the transport of wood. It has been estimated that, by the higher prices which the town receives at the sale of the wood on account of the easier transport, the capital invested in making these roads and keeping them in good condition yields 20 per cent yearly.

SUCCESSFUL BRAIN GRAFTING.

A PAPER on the above subject, by W. Gilman Thompson, M.D., appeared in the *New York Medical Journal* for June 28, 1890. Attempts have been made to graft nearly all the different tissues of the body. Skin, bone, teeth, muscle, nerves, glands, eyes, mucous membrane, etc., have all been grafted with more or less success, but successful brain grafting has not heretofore been performed. With the exception of skin grafting, and possibly mucous-membrane grafting, the results of such experiments have been of little practical value. They are, however, of great scientific interest in demonstrating the relative vitality of different tissues and the histological changes which accompany degenera-

tive processes. The laws of atrophy and final disappearance of disused organs, so ably advocated by Darwin, are equally striking with regard to individual tissues and cells, and it is a well-recognized fact that the higher the original development of a tissue or cell has been—i.e., the more it has been differentiated or specialized from the amoeba type—the more profoundly is it affected by alterations in environment or nutrition, so as to degenerate completely, or be replaced by some form of tissue like the connective, which is of lower development but stronger vitality. The result of nerve grafting and of nerve suture after complete section have varied greatly in the hands of different operators, but, despite many discouraging failures, there is no doubt that in man, as well as in the lower animals, nerve fibres may reunite when sutured even after secondary degeneration has occurred, and they exhibit restoration of function. For this to occur, however, the nerves must be in communication with some trophic centre. Nerve grafting does not succeed so well as nerve sutures in favorable cases. It occurred to Dr. Thompson recently, while studying cerebral localization in the lower animals, that it would be interesting to graft a piece of brain tissue from one side of a dog's brain to the other, or from one animal's brain into another's, and study its vitality. Of course, he had no expectation of being able to restore abolished function by the operation, but the question of vitality of the brain tissue and the course of its degeneration is a subject which is of very wide interest. The first experiments were preliminary, made in order to ascertain whether the transplanted brain would be immediately absorbed or would slough away.

No microscopic examination was made in connection with these experiments, as it was intended only to determine the possibility of the transplanted tissue adhering. Being satisfied in regard to this matter, Dr. Thompson secured a large dog and performed his experiment. A half-inch trephine was used and a button of bone was cut nearly through over the left occipital region, leaving a small attached margin so that the button could be elevated and then depressed like a little trap-door. Through the opening 2 c.c. of brain tissue were removed. A cat was simultaneously trephined and 1.5 c.c. of brain from her left occipital region were transferred in eight seconds to the opening in the dog's brain.

The features of interest of this experiment are the facts that:

1. There was complete union, through organized connective tissue, of the contiguous portions of the two brains.
2. After seven weeks the cat's brain still maintained enough vitality to be distinctly recognized as brain tissue.
3. Brains of animals of two very different species were thus made to unite.
4. The cat and dog pias presented perfect union as well.
5. There was a sympathetic degeneration of the corresponding convolutions upon the opposite side of the dog's brain. For this curious fact Dr. Thompson can not account. He had never noticed it before, in as many as fifty operations upon this region of the brain of cats and dogs, although he had sometimes seen removal of a part of the occipital region result in extensive softening of the entire hemisphere of the same side. The opposite degeneration in this case may possibly be a mere coincidence; if so, it is a very unusual and remarkable one. There was no meningitis to favor it.
6. There was descending secondary degeneration of the dog's brain on the side of the graft, as is usual in cases of simple excision of brain cortex; hence the cat's cortex had not succeeded in acting as a nutrient centre for the dog's brain.

Dr. Thompson thinks the main fact of this experiment—namely, that brain tissue has sufficient vitality to survive for seven weeks the operation of transplantation without wholly losing its identity as brain substance—suggests an interesting field for further research, and he has no doubt that other experimenters will be rewarded by investigating it.

LETTERS TO THE EDITOR.

Temperature in Storms, and High Areas.

THERE are two classes of cases in which the temperature is higher on Mount Washington than at surrounding stations at a lower level. By far the most frequent of these is when the crest of an anti-cyclone has just passed that locality. For example, on

May 22, 1887, at 7 A.M., the temperature on Mount Washington was 58°, with fair weather, and wind velocity 26 miles, from the north-west. At Portland the temperature was 52°, at Boston 56°, at Eastport 44°, at Montreal 44°, the winds being from the south-east and light. The isobar 30.40 was over Nova Scotia, and that of 29.90 was over Lake Superior. On Feb. 26, 1887, at 7 A.M., New England was enclosed by the isobar 30.40, a low centre, 29.40, being over Wisconsin. The temperature on Mount Washington was +8°, at Portland +2°, at Montreal -10°, at Albany +8°, and at Eastport +2°. On Feb. 2, 1887, the isobar 30.90 was located directly north of New England, and there was no low centre nearer than Utah and Colorado. The temperature on Mount Washington was +5°, at Portland +4°, at Eastport -3°, at Montreal -10°. On March 6, 1887, the temperature on Mount Washington was 15°, at Portland 14°, at Eastport 15°, and at Quebec 7°. The isobar 30.60 appeared in Nova Scotia. On Dec. 31, 1886, at 7 A.M., the isobar 30.60 was located in Nova Scotia, and that of 29.80 in Tennessee. The temperature on Mount Washington was +9°, at Portland +2°, at Montreal -7°, with winds generally from northerly points except on Mount Washington, where they were from the west. On Dec. 26, 1886, the isobar 30.40 was over Maine, and that of 29.80 over the upper lakes; temperature on Mount Washington +14°, at Portland +10°, at Montreal -2°, at Albany +12°, at Boston +15°. On Jan. 17, 1887, at 7 A.M., the isobar 30.50 was over the maritime provinces, and 29.30 over Michigan; temperature +20° at Mount Washington, +8° at Portland, and +17° at Albany. On Jan. 4, 1887, at 7 A.M., the isobar 30.70 enclosed New Hampshire, southern Vermont, and south-eastern New York. Within these limits at the very crest of the anti-cyclone the temperature on Mount Washington was -1°, at Portland -7°, and at Albany -4°.

Numerous other instances of the kind might be cited, and the list might be greatly enlarged also by admitting cases in which an approach to inversion of temperature was apparent although not fully attained.

The other class of cases in which there has been an inversion of temperature are much more rare and difficult to define, being due apparently to temporary anomalous conditions of one sort or another. For example, on Jan. 10, 1887, at 7 A.M., the temperature on Mount Washington was +10°, at Portland +8°, at Boston +14°, and at Eastport +30°, although a low centre surrounded by the isobar 29.50 was located in Maine. The isobar 30.00 appeared over New Brunswick, as in the previous cases, however, and the isotherms were very much crowded, there being a gradient of 30 degrees between Nova Scotia and New Brunswick. In like manner on Dec. 16, 1886, there was a low centre, 29.50, off the New England coast, and an unusually confused arrangement of the isobars and isotherms toward the north-west, a low centre, 29.80, being over Lake Huron, with the isotherms +50° over Nova Scotia and -10° near Rockcliffe, Canada. Coincidentally with this anomalous condition the temperature was somewhat higher on Mount Washington than at surrounding stations.

As a rule, however, increased divergence of temperature between Mount Washington and surrounding stations attends and follows the passage of cyclonic centres. For example, on April 30, 1887, the isobar 29.20 covered portions of Maine and New Hampshire, this being the very centre of the low area. On Mount Washington the temperature was 26°, at Portland 46°, at Boston, 50°, at Montreal 39°, at Albany 43°, gradually decreasing westward to the lake region, where an anti-cyclone was located. On March 25, 1887, at 7 A.M., the centre of a cyclone was exactly over New Hampshire, with pressure 29.20, and temperature on Mount Washington +20°, at Portland +39°, at Montreal +25°, at Quebec +28°, at Boston +46°, at Albany +35°. On Sept. 8, 1887, at 7 A.M., a low centre, 29.40, was at Father Point, Canada, and the barometric trough extended thence south-westward into Maine. At Mount Washington the temperature was 28°, at Portland 60°, at Montreal 54°, and at Quebec 52°. With the distribution of pressure just described, wide divergence of temperature between Mount Washington and surrounding stations is extremely common, and it is not necessary to multiply illustrations. The contrast with the comparative equalization of temperature at

these stations attendant upon and immediately following the passage of the crest of anti-cyclones over New England is very striking.

The results of these observations may perhaps be summarized briefly in the statement that temperature changes indicate their approach at the summit of Mount Washington sooner than at its base. Thus, the departure of an anti-cyclone is signalized by a rise of temperature amounting, in the cases above described, to an actual inversion of temperature as compared with surrounding stations. In like manner the departure of a low centre is marked by decided decrease of temperature at the summit as compared with lower levels. In the former case there is equalization and in the latter case increased divergence of temperature at different altitudes. Hence it follows that relatively warmer air overlaps an anti cyclone at least as far east as its crest, and in like manner relatively colder air tends to overlap the warm air at cyclonic centres, but the extent to which it does so is not so clearly defined as in the case of the anti-cyclone.

M. A. VEEDER.

Lyons, N.Y., Aug. 1.

Dr. Sprung: Remarks on the General Wind-Systems of the Earth.

IN the *American Journal of Science* for April I have called attention to the recent activity on the part of investigators in the field of dynamical meteorology. In that paper no attempt was made to give any opinion as to the relative merits of the different theories advanced. There could be no doubt but that a critical review of the subject was very much needed, but it must be at the hands of some one who had mastered the different theories with a thoroughness which would permit of his making a just estimate of the value of the ideas advanced by the writers. There was no doubt in my mind as to who was a (perhaps I should say the) proper person to give us this estimate. I refer to Dr. Adolph Sprung. It was with the greatest pleasure, then, that, on taking up the May number of the *Meteorologische Zeitschrift*, I found there a paper of sixteen pages by Sprung, in which he had given his views as to the correctness of the methods and some of the main results arrived at in these recent papers.

But before giving a synopsis of this *referat*, it may not be out of place to say a few words about Dr. Sprung's work, as he is probably known to but few of the present readers in any other capacity than the author of the "Lehrbuch of Meteorology," which gives us such an excellent presentation of the modern theories concerning statical and dynamical meteorology. Dr. Sprung's contributions to meteorology extend over a period of about fifteen years, and cover a wide range of topics. But there are two distinct lines in which he has made his name especially prominent as a specialist: viz., those which relate to self-registering instruments, and the mechanics of the atmosphere. He has devised a self-registering apparatus of great accuracy, which is gradually receiving a wide adoption; and the fact that its construction is in the hands of the leading German meteorological instrument-maker is itself a guaranty of its excellence. The names of "Wild" and "Sprung" will always be associated with the development of this important branch of meteorology.

It is, however, of Sprung's connection with the second topic, that of dynamical meteorology, that I wish to make special mention at the present time. From the commencement of his meteorological labors at the Deutsche Seewarte he has been a careful student of this subject; and his acquaintance with its now extensive literature is not of a cursory nature, but admits of his using the methods and results of contributors in a manner which denotes thorough comprehension. Judging from Sprung's writings, as well as by a long personal intercourse with him, I feel justified in saying that no one has a better knowledge than he, of the contents of the hundred papers which cover the field of dynamical meteorology. I do not know of a better example of the thoroughness of this study than his review of Part II. of Ferrel's "Meteorological Researches," which he published in the *Oesterreiche Zeitschrift für Meteorologie* nearly ten years ago. In this same connection I may also say that no other person has done so much as Dr. Sprung towards making generally known to Europeans the great service of Professor Ferrel to meteorology.

In the comparative treatment given by Sprung in the paper now under consideration, he prefaces it by some general remarks which are of interest to us; and I will give an abstract of these, as well as of portions of the main paper.

The general circulation of the atmosphere has been lately the subject of theoretical investigation, and principally by German investigators, although earlier — through a number of years — the workers in this field had been almost exclusively Americans, and foremost of all was William Ferrel. But in 1886 Werner von Siemens published an important paper, which was the first of the series just referred to. In this investigation the results already obtained by Ferrel in his earlier works were not made use of, and the matter was treated from the first principles. But in all of the investigations an ideal and homogeneously formed earth's surface is presupposed; that is, it is assumed to consist everywhere of water or land of like qualities. On this supposition there is built up an ideal pressure distribution and system of winds. Moreover, all of the systems agree with the view so long ago advanced by Hadley, as to the initial cause of the atmospheric circulation.

The theory of Werner von Siemens is first outlined, not because it is the oldest of the modern views, but because it is the simplest. It may be briefly stated as follows: We must conceive the air to be everywhere at relative rest; the atmosphere will then possess, by means of its absolute motion of rotation, a certain amount of living force K . Now suppose the whole atmosphere to be suddenly thoroughly stirred up. Then, according to Siemens, there will be produced an everywhere uniform velocity of rotation C , and of such an amount that the total living force is just the same as before.

We will determine C . By definition

$$(1) \quad K = \frac{mV^2}{2},$$

where m denotes the mass of a quantity of air, and V its absolute velocity of rotation (that towards east is positive); under which supposition we have

$$(2) \quad V = \omega R \cos \phi,$$

where R is the radius of the earth (considered as a sphere), ω is its constant angular velocity, and ϕ the geographical latitude. In order to represent the mass m , covering a small ring at the latitude $R d\phi$ and radius $R \cos \phi$, we will designate by μ the mass (assumed to be uniform) over the unit of surface: we have, then, (3) $m = 2\mu R^2 \pi \cos \phi d\phi (= dM$, where M signifies the mass of the whole atmosphere): consequently

$$K = \mu R^4 \omega^2 \pi \int_{-\frac{1}{2}\pi}^{\frac{1}{2}\pi} \cos^3 \phi d\phi.$$

In general,

$$(4) \quad \int \cos^3 \phi d\phi = \frac{\sin \phi}{3} (2 + \cos^2 \phi)$$

which for the limits $\frac{1}{2}\pi$ and $-\frac{1}{2}\pi$ reduces to $\frac{4}{3}$; therefore we have finally

$$(5) \quad K = \frac{4}{3} \mu R^4 \omega^2 \pi.$$

If, now, the computation of the living force for a uniformly equal velocity C furnishes the same amount, then

$$K = \Sigma \frac{m C^2}{2} = C^2 \Sigma \frac{m}{2}, \text{ or}$$

$$(6) \quad C^2 = \frac{2K}{\Sigma m}.$$

From (3) we have, then,

$$(7) \quad M = \Sigma m = 2\mu R^2 \pi \int_{-\frac{1}{2}\pi}^{\frac{1}{2}\pi} \cos \phi d\phi = 4\mu R^2 \pi.$$

By consideration of (5) we have, then,

$$(8) \quad C = R \omega \sqrt{\frac{4}{3}} (= 379 \text{ metres per second}).$$

Subtracting from this $R \omega \cos \phi$, the motion of the earth at the latitude ϕ , and we get the relative easterly motion v ; then from (8) and (2) we have

$$(9) \quad v = R \omega (\sqrt{\frac{4}{3}} - \cos \phi).$$

It is of special interest to find the latitude ϕ_0 in which $v = 0$. This gives

$$(10) \quad \begin{cases} \cos \phi_0 = \sqrt{\frac{4}{3}} \\ \phi = 35^\circ 16'. \end{cases}$$

For the belt between the two parallels of 35° , there must be, according to (9), a westerly air-current (east wind) which is greatest

at the equator (85 metres per second); while everywhere beyond latitude 35° there is a west wind which acquires its greatest velocity (379 metres per second) at the pole. In this computation a frictionless motion is considered. The distribution of the air-pressure corresponding to this has been worked out by Liebenow, and published in the *Naturwissenschaftlichen Rundschau*, Jahrgang III. p. 237, but it has no practical significance for meteorologists.

Ferrel's reasoning gives for v , the relative linear velocity of rotation, in the latitude ϕ , the following expression:—

$$v = R \omega \left\{ \frac{2}{3 \cos \phi} - \cos \phi \right\};$$

that is, $v = 0$ for $\cos^2 \phi = \frac{2}{3}$ or $\phi = 35^\circ 16'$.

For $\phi > 35^\circ 16'$, v is positive (west wind).

For $\phi < 35^\circ 16'$, v is negative (east wind).

Ferrel's and Siemens's researches were independent of each other, but their apparently complete agreement is in reality only a partial one. They agree as to the dividing-line between the easterly and westerly air-currents (the first three being from the east, and the last four from the west); but the following little table shows how widely their computed velocities (expressed in metres per second) differ.

	Siemens.	Ferrel.
For $\phi = 0^\circ$	85	155
" $\phi = 20^\circ$	57	107
" $\phi = 35^\circ 16'$	0	0
" $\phi = 45^\circ$	51	110
" $\phi = 54^\circ$	106	254
" $\phi = 70^\circ$	220	747
" $\phi = 90^\circ$	379	∞

In both cases there are assumed three facts: (1) The friction is not considered; (2) The initial condition is relative rest; (3) Thorough mixing of the air is accomplished by meridional motions. There are certain inaccuracies of deduction existing in both theories, so that we cannot say without qualification that one is right and the other wrong. Siemens seems to have fallen into the error of the Hadley-Dove view, that masses of air passing from one parallel to another retain unchanged their absolute velocity of rotation. It is one of the main points of Ferrel's theory, that this does not remain constant, but increases with the approach towards the axis of the earth. The following quotation from Helmholtz's memoir "Ueber Atmosphärische Bewegungen" (*Meteorologische Zeitschrift*, 1888, p. 329) shows his complete agreement with Ferrel. He says, "If we consider a rotating belt of air, whose axis coincides with the axis of the earth, and which is pushed first a little to the north and then a little to the south by the pressure of the adjoining similar belt, then, if the friction is not considered, according to the well-known general mechanical principle, the moment of rotation must remain constant." This can be true only when the angular velocity of the belt changes in an inverse proportion to the square of its radius. The two velocities at the poles obtained by Ferrel and Siemens, and given in the table, are both far removed from the true value; but in either case there would be a crowding-back of the air from the axis of rotation, because such great velocities of rotation are impossible. Ferrel, however, in his further development, so limits the theoretical conditions that these impossible velocities are modified into possible conditions. It is quite amusing that some readers of Ferrel's writings have understood him to make the ridiculous statement that all of the results found by his purely theoretical deductions do actually exist in nature; and they claim that such absurdities are sufficient to cause his theory to be rejected. It merely shows that such persons have only glanced at Ferrel's writings.

(a) The resistances to motion, such as friction and the like, make it impossible that such a great increase as Ferrel and Siemens figure out can occur in the relative motions of the air;

and Helmholtz has given his views of this action, in the paper previously mentioned.

(b) Again: the mixing-up of the air does not occur in the assumed uniform manner which requires that all the air, no matter what its altitude is, which proceeds from about the latitude of 35° , reaches all other latitudes. As an actual fact, we find that the motion toward the pole, towards gradually narrowing circles of latitude, takes place mostly in the higher layers of the atmosphere, and the opposite motion in the lower layers. According, then, to the law of the conservation of areas, we owe to the upper movements the west wind, and to the lower the east wind.

The modifications of this simple scheme which are necessary to account for the observed wind phenomena are next discussed by Dr. Sprung, who gives special attention to the recently expressed views of Dr. Peruter (see *Wetter*, p. 11, 1890; also given in a lecture at Vienna, Nov. 7, 1889), concerning the lack of an upper south-west trade-wind between the two parallels of 35° latitude; his view being based on the theories of Siemens and Oberbeck, and in opposition to that of Ferrel. Professor Abbe's recent studies of cloud-motions in the tropics will be very useful in this connection. The tendency towards the origination of a tropical east wind is far more marked in the theory of Ferrel than in that of Siemens. That the actual wind circulation as marked out by these two investigators are so contradictory seems to be due to the fact that Siemens simply combined with the weak meridional surface currents the results obtained in (9), without considering that this is sensibly changed by the conditions explained under (6). Ferrel, on the contrary, carefully investigated the gradients of air pressure, and found that the east wind of the tropics could be perceived to only a limited extent.

Sprung's trite references to the recent works of Oberbeck (*Sitzungsberichte Berlin Akademie*, March 5 and Nov. 8, 1888) and Möller (*Archiv der Seewarte*, vol. 10), and his own attempt to treat this question of the upper anti-trades in an empirical manner, cannot be discussed in the present short communication. The last section (five pages) of Sprung's paper is of special importance to the student of this question of general motions, for he treats analytically the reasons for the use of the principles adopted in Siemens's paper.

FRANK WALDO.

Mount Lake Park, Md., July 29.

A Brilliant Meteor.

ON Sunday night, July 27, at 11.15 P.M., while sitting on the piazza looking west, I saw a remarkable meteor, which in size and slowness of movement resembled that of 1861 (which I also saw).

It appeared from beneath the edge of one of the fleecy streaks of cloud with which the sky was full, about forty degrees above the horizon. Its path was downward, very slightly southward. When it first appeared, it rapidly increased in size to a large sphere of brilliant white light, changing immediately to a pale apple-green as it descended, followed by a train of dark-red glowing particles. Its duration above the horizon was about two seconds.

The clouds were not thick enough to obscure the light of third-magnitude stars.

Sea Girt, N.J., July 30.

F.

BOOK-REVIEWS.

Hypnotism. By ALBERT MOLL (of Berlin). (Contemporary Science Series.) New York, Scribner & Welford. 8c.

HAVING noticed the general plan and scope of this work upon the appearance of the original German edition (*Science*, July 19, 1889), it may suffice to express briefly our appreciation of the value of this contribution to the English literature on hypnotism. We have had a translation of Bernheim's important work, and of Krafft-Ebbing's treatise on the subject from the more strictly medical point of view, and translations of Binet and Féré, and of Björnström, giving more general expositions of hypnotic phenomena. It is with the latter class of works that Dr. Moll's invites comparison. It is much fuller and more thorough than Björn-

ström's useful sketch, and notably more cautious and judicious than Binet and Féré's somewhat one-sided exposition. The arrangement of the work is a practical one, and its utility has been increased by the changes incorporated in the second edition; the very complete index, and notice of authors, being among them.

The growth of interest in hypnotism characteristic of the last few years is certainly remarkable. A great deal of it is due to a general interest in strange mental states and appearances on the borderland of the knowable. This interest, while a natural and in some respects a useful one, is in danger of lapsing into an idle curiosity, if not an uncritical credulity. Then there is an interest in the practical side,—the hopes of aiding the arrest of disease, and the furthering of mental and physical well-being; and there is the much more limited psychological interest in the phenomena for their value in contributing to an analysis of the elements and modes of combination of mental and physiological processes. To correctly guide public interest, avoiding a semi-morbid interest in the unusual,—a link detached from the chain that connects it with the normal,—directing attention to the essential meaning of the phenomena, their relation to facts longer known and better understood, and furthering a calm attitude of judicial poise when confronted with apparent exceptions to all natural laws,—this is a task as difficult as it is important, and must be the object of every book not appealing to a professional audience. It is as contributing to such an end that the present volume is welcome. It is not a perfect volume in this respect, but it is as good as, if not better than, any we have.

AMONG THE PUBLISHERS.

THE "Catalogue of Minerals" just issued by Geo. L. English & Co. (1512 Chestnut Streets, Philadelphia, and 739 Broadway, New York,) is more than the ordinary price-list. Every one interested in the subject should write for a copy, which is, in paper covers, mailed free. The catalogue contains classified lists of all mineral species described up to June 1, with their chemical com-

position and crystallographic form. We do not recall having seen so attractive and valuable a catalogue issued by any other dealers. The purpose is, of course, to furnish a price list of the firm's stock, but so much more is added that the result is one for which Messrs. Geo. L. English & Co. are to be commended.

—Lord & Thomas of Chicago announce that they have in preparation, and will issue during this month, their "Complete Directory of the American Press."

Messrs. Ginn & Co. announce to be published early in the autumn "A Synopsis of English and American Literature," by G. J. Smith, of the Washington, D. C., High School. This work contains in small compass the most important facts connected with English and American writers from the days of the Celtic bards to the present time. The first part of the book is devoted to English, the last part to American literature, each carefully divided into periods, and logically outlined. Every period is briefly described, and every writer of importance is mentioned, with the titles and dates of publication of his principal writings, the characteristics of the most celebrated authors and works being set forth in apt quotations or in a few discriminating words. A separate column on every page gives the leading events and personages of contemporary history in useful association with the literature. The rank of authors, indicated throughout the work by difference in type, is definitely set forth in a summary at the end. A list of books suggested as desirable for a course of reading is an additional feature of much value.

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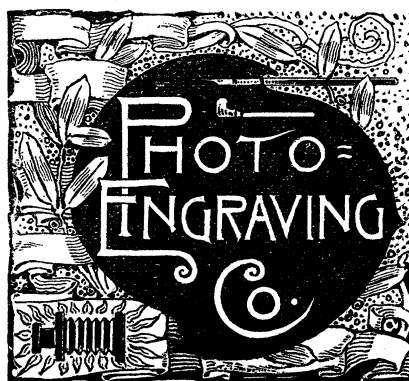
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